WHAT IS CLAIMED IS:

Sub A4

1. A method of forming a planar waveguide structure, comprising:

forming a first graded layer on a substrate, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the first graded layer; and

forming a second graded layer on the first graded layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

2. The method of claim 1 further comprising forming a blocking layer between the substrate and the first graded layer wherein the blocking layer prevents contaminants from the substrate from diffusing into the first or the second graded layers.

3. The method of claim 2 wherein the blocking layer comprises epitaxial silicon.

4. The method of claim 1 further comprising forming a cladding layer on the second graded layer.

5. The method of claim 4 wherein the cladding layer comprises epitaxial silicon.

6. The method of claim 1 wherein the germanium concentration in the first graded layer increases linearly.

7. The method of claim 1 wherein the germanium concentration in the graded layer increases from about 0% germanium to about 2-5% germanium at a rate between about 0.1% per μm to about 10% per μm.

8. The method of claim 1 wherein the germanium concentration in the first graded layer increases from about 0% germanium to about 2% germanium at a rate of about 10 % per μm.

9. The method of claim 1 wherein the germanium concentration in the second graded layer decreases linearly.

10. The method of claim 1 wherein the germanium concentration in the second graded layer decreases from about 2-5% germanium to about 0% germanium at a rate between about 0.1% per μm to about 10% per μm.

11. The method of claim 1 wherein the germanium concentration in the second graded layer decreases from about 2% germanium to about 0% germanium at a rate of about 10% per μm.

12. The method of claim 1 wherein the layers are formed by a chemical vapor deposition process.

13. The method of claim 12 wherein the layers are formed epitaxially.

14. The method of claim 12 wherein the chemical vapor deposition process is a low pressure chemical vapor deposition process.

15. The method of claim 13 wherein the waveguide structure is formed using a selective deposition technique.

Sub A5

16. The method of claim 13 wherein the chemical vapor deposition process comprises

introducing into a deposition chamber a first source gas for forming silicon film on a substrate;

introducing into a deposition chamber a second source gas for forming SiGe film on a substrate;

introducing H_2 into the deposition chamber

while maintaining a determined pressure and temperature in the deposition chamber.

17. The method of claim 16 wherein the first source gas is silane, disilane, trisilane, dichlorosilane, or trichlorosilane.

18. The method of claim 16 wherein the second source gas is germane or digermane.

19. The method of claim 16 wherein the first source gas is silane and the second source gas is germane.

Sub A16

20. The method of claim 16 wherein the chemical vapor deposition process for forming the first and second graded layers comprises

controlling the flow rate of the second source gas according to a determined concentration profile of Ge on a substrate;

forming a film on a substrate, the film comprising Ge at a first concentration at a first point in the film and a second concentration different from the first concentration at a second point in the film.

21. The method of claim 20 wherein the concentration profile is determined by:

determining a concentration of Ge formed on a substrate for a plurality of flow rates;

determining a growth rate of SiGe on a substrate for a second plurality of flow rates;

determining a concentration profile of Ge for a unit of time; and

controlling the flow rate to form film at a graded concentration of Ge throughout the thickness of the film.

22. The method of claim 1 further comprising:

forming a pattern on the first graded layer; and

etching the patterned first graded layer before forming the second graded layer on the first graded layer.

Sub A7

23. A method of forming a planar waveguide structure, comprising:

forming a first graded layer on a substrate, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the layer;

forming a uniform layer on the first graded layer, the uniform layer containing silicon and germanium wherein the germanium concentration is constant;

forming a second graded layer on the uniform layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

24. The method of claim 23 wherein the germanium concentration in the uniform layer is in the range of about 2 - 5 %.

25. The method of claim 23 wherein the germanium concentration in the uniform layer is approximately 2%.

26. The method of claim 23 wherein the thickness of the uniform layer is in the range of about 2-5 μm.

27. The method of claim 23 wherein the thickness of the uniform layer is approximately 2 μm.

28. The method of claim 23 further comprising forming a blocking layer between the substrate and the first graded layer.

Sub A9

29. The method of claim 29 wherein the blocking layer is epitaxial silicon.

30. The method of claim 23 further comprising forming a cladding layer on the second graded layer.

Sub A9

31. The method of claim 30 wherein the cladding layer is epitaxial silicon.

32. The method of claim 23 wherein the germanium concentration in the first graded layer increases linearly.

33. The method of claim 23 wherein the germanium concentration in the first graded layer increases from about 0% germanium to about 2-5% germanium at a rate between about 0.1 % per µm to about 10% per µm.

34. The method of claim 23 wherein the germanium concentration in the first graded layer increases from about 0% germanium to about 2% germanium at a rate of 10 % per µm.

35. The method of claim 23 wherein the germanium concentration in the second graded layer decreases linearly.

36. The method of claim 23 wherein the germanium concentration in the second graded layer decreases from about 2-5% germanium to about 0% germanium at a rate between about 0.1 % per µm to about 10% per µm.

37. The method of claim 23 wherein the germanium concentration in the second graded layer decreases from about 2% germanium to about 0% germanium at a rate of about 10 % per µm.

38. The method of claim 23 wherein the layers are formed using a chemical vapor deposition process.

39. The method of claim 38 wherein the layers are formed epitaxially.

40. The method of claim 38 wherein the chemical vapor deposition process is a low pressure chemical vapor deposition process.

41. The method of claim 38 wherein the waveguide structure is formed using a selective deposition technique.

Sub A10

42. The method of claim 29 wherein the chemical vapor deposition process comprises

introducing into a deposition chamber a first source gas for forming silicon film on a substrate;

introducing into a deposition chamber a second source gas for forming SiGe film on a substrate;

introducing H_2 into the deposition chamber

while maintaining a determined pressure and temperature in the deposition chamber.

43. The method of claim 42 wherein the first source gas is silane, disilane, trisilane, dichlorosilane, or trichlorosilane.

44. The method of claim 42 wherein the second source gas is germane or digermane.

45. The method of claim 42 wherein the first source gas is silane and the second source gas is germane.

Sub A11

46. The method of claim 42 wherein the chemical vapor deposition process for forming the first and second graded layers comprises

controlling the flow rate of the second source gas according to a determined concentration profile of Ge on a substrate;

forming a film on a substrate, the film comprising Ge at a first concentration at a first point in the film and a second concentration different from the first concentration at a second point in the film.

47. The method of claim 46 wherein determining the concentration profile comprises:

determining a concentration of Ge formed on a substrate for a plurality of flow rates;

determining a growth rate of SiGe on a substrate for a second plurality of flow rates;

determining a concentration profile of Ge for a unit of time; and

controlling the flow rate to form film at a graded concentration of Ge throughout the thickness of the film.

48. The method of claim 23 further comprising:

forming a pattern on the uniform layer; and

etching the patterned uniform layer and the first graded layer before forming the second graded layer on the uniform layer.

49. The method of claim 48 further comprising:

forming an oxide layer on the etched patterned uniform layer before forming the second graded layer on the uniform layer.

50. The method of claim 49 wherein the height of the oxide layer is approximately equal to the height of the first graded layer.

Sub A12

51. A computer readable medium comprising executable program instructions that when executed cause a digital processing system to perform a method comprising:

forming a first graded layer on a substrate, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the first graded layer;

forming a second graded layer on the first graded layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

52. The method of claim 51 wherein the executable program instructions include instructions for forming layers using chemical vapor deposition process.

Sub A13

53. The method of claim 51 wherein the chemical vapor deposition process comprises executable program instructions for:

introducing into a deposition chamber a first source gas for forming silicon film on a substrate;

introducing into a deposition chamber a second source gas for forming SiGe film on a substrate;

introducing H_2 into the deposition chamber

while maintaining a determined pressure and temperature in the deposition chamber.

54. The method of claim 51 wherein the executable program instructions for forming the first and second graded layers comprises instructions for:

controlling the flow rate of the second source gas according to a determined concentration profile of Ge on a substrate;

forming a film on a substrate, the film comprising Ge at a first concentration at a first point in the film and a second concentration different from the first concentration at a second point in the film.

55. The method of claim 54 wherein the executable program instructions for determining the concentration profile comprises instructions for:

determining a concentration of Ge formed on a substrate for a plurality of flow rates;

determining a growth rate of SiGe on a substrate for a second plurality of flow rates;

determining a concentration profile of Ge for a unit of time; and

controlling the flow rate to form film at a graded concentration of Ge throughout the thickness of the film.

56. The method of claim 51 wherein the executable program instruction include instructions for forming the layers epitaxially.

Sub A14

57. A method of forming a planar waveguide structure, comprising:

etching a pattern in a substrate;

forming a first graded layer on the pattern etched in the substrate, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the layer;

forming a uniform layer on the first graded layer, the uniform layer containing silicon and germanium wherein the germanium concentration is constant;

forming a second graded layer on the uniform layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

58. The method of claim 57 further comprising planarizing the uniform layer prior to forming the second graded layer.

59. The method of claim 58 wherein the planarizing step is performed using a chemical mechanical polishing process.

60. A method of forming a planar waveguide structure, comprising:

forming a first graded layer on a substrate, wherein the first graded layer comprises a first and a second optical material, wherein the concentration of the first optical material and the index of refraction of the first graded layer increases with the height of the first graded layer;

forming a second graded layer on the first graded layer, the second graded layer comprising the first and second optical materials wherein the concentration of the first optical material and the index of refraction of the second layer decreases with the height of the second graded layer.

61. A method of forming a planar waveguide structure, comprising:

forming a first graded layer on a substrate, wherein the first graded layer comprises a first and a second optical material, wherein the concentration of the first optical material and the index of refraction of the first graded layer increases with the height of the first graded layer;

forming a uniform layer on the first graded layer, the uniform layer containing first and second optical materials wherein the first optical material concentration is constant;

forming a second graded layer on the first graded layer, the second graded layer comprising the first and second optical materials wherein the concentration of the first optical material decreases with the height of the second graded layer;

wherein the index of refraction of the uniform layer is greater than the index of refraction of the first and the second graded layers.

62. A method of forming a planar waveguide structure, comprising:

forming a uniform layer on a substrate, the uniform layer containing primarily epitaxial silicon germanium wherein the germanium concentration is constant.

63. The method of claim 62 further comprising:

forming a cladding layer on the uniform layer, the cladding layer containing primarily epitaxial silicon.

64. The method of claim 62 further comprising:

forming a pattern on the uniform layer; and

etching the patterned uniform layer.

65. The method of claim 64 further comprising:

forming a cladding layer on the patterned etched uniform layer, the cladding layer containing primarily epitaxial silicon.

66. The method of claim 62 further including forming a graded layer on the uniform layer, wherein the concentration of germanium decreases with the height of the graded layer, the graded layer comprising primarily of epitaxial silicon germanium.

67. The method of claim 66 further including forming a cladding over the graded layer, the cladding layer comprising primarily epitaxial silicon.